EDDY'S SOLUTION OF A PROBLEM IN GRAPHICAL STATICS.*

In these two papers, Prof. Eddy, whose important contributions to the subject of Graphical Statics are familiar to American engineers and mathematicians, has developed at considerable length a branch of the subject which, though not entirely new, has been comparatively unexplored. The importance of these papers is such that they merit more than a passing notice.

As is well known, the use of actual concentrated loads in proportioning the members of a bridge is frequently specified by bridge engineers, and although this leads to an apparent accuracy which is for the most part illusory (owing to various necessary inaccuracies in our theories, the effect of shock and impact, and the fact that the heaviest actual loads vary from time to time), yet it is evident that such actual loads, whether used directly or indirectly, must at least form the *basis* of all such computations.

The principle upon which Prof. Eddy's method is based is the construction of a stepped line or *load line*, in which the horizontal distances between steps represent the distances apart of a system of loads, and the heights of the steps the loads themselves. From this load line, two irregular lines (reaction lines) may be drawn, one above and one below the load line. These reaction lines are parallel and at a constant horizontal distance apart, and they are so constructed that their vertical distances from the load line, at the ends of any span , represent the reactions at the ends of such a span in the assumed position. Reaction lines must be drawn for as many different spans as it is desired to treat.

By means of the load line and the reaction lines, almost all questions relating to shears and moments may be solved, such as the following: the reactions for any position of the given loads; the centre of gravity of the loads; the loads on the joints of a truss; the loading producing maximum shear at any point of a girder or in any panel of a truss, and the value of such shear; the segments of a span in which the maximum shear at any section is dominated by each successive wheel, or, in other words, occurs with that wheel at the section; the loading giving maximum moment at any

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* Prof. Henry T. Eddy, Ph. D. A new Graphical Solution of the Problem, What position a Train of Concentrated Loads must have in order to cause the greatest stress in any given part of a Bridge Truss or Girder. (Transactions of the American Society of Civil Engineers, 1890.)

The same. Auflagerdrucklinien und deren Eigenschaften. (Zeitschrift für Bauwesen, 1890, pp. 397-415.)

point, together with the maximum moment itself, in a girder or truss. In fact, all the usual problems regarding moments and shears may be solved with ease and expedition, some from the load line alone, and others with the aid of the reaction lines, which are supposed drawn on a large diagram for many different spans. Some of the results reached are merely graphical representations of principles which were long ago known and used, while others are new.

The method used in this paper is not a purely graphical one, but rather an analytical one *interpreted graphically*; that is to say, analytical expressions are first deduced for the functions or conditions required and then, by algebraic transformations which are often somewhat complicated, but ingenious in the extreme, these expressions are brought into forms in which their terms are easily shown to represent certain distances, ratios, or angles on the diagram, and the analytical result is thus graphically interpreted.

In Part II of the paper, the author extends the method to finding shears, moments, and stresses in cantilevers and in double intersection trusses.

As a contribution to mechanics, these papers are very interesting, and will repay careful study. For the designing engineer, too, they offer many suggestions which will prove of value. Against the extended practical use of many of the theorems, however, one strong argument suggests itself. It is of the first importance for the computer, in working out his results, to use a method which is *simple*, and which allows him to see, at any stage, just where he is and what he is doing; otherwise he is liable to mistake, and an error may remain undiscovered. A method, therefore, which involves deducing an analytical expression, and then transforming it by an extended and complex process, which conveys no concrete idea but is merely a mathematical device, leads to a result the concrete relation of which to the problem cannot be perceived; and from this point of view many designers will much prefer to use analytical or other graphical methods (of which there are many) which afford a clearer view of the whole problem, and enable the computer to see the bearing of each step in the process. This criticism, however, does not apply to all the theorems in the paper, and the practical designer who takes the time to carefully study the subject will be well repaid.

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